KOKAI PATENT APPLICATION NO. HEI 2000-202613

PRODUCTION OF A CYLINDER BLOCK

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PRODUCTION OF A CYLINDER BLOCK

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[*There are no amendments to this patent.*]

(54) [Title of the Invention]

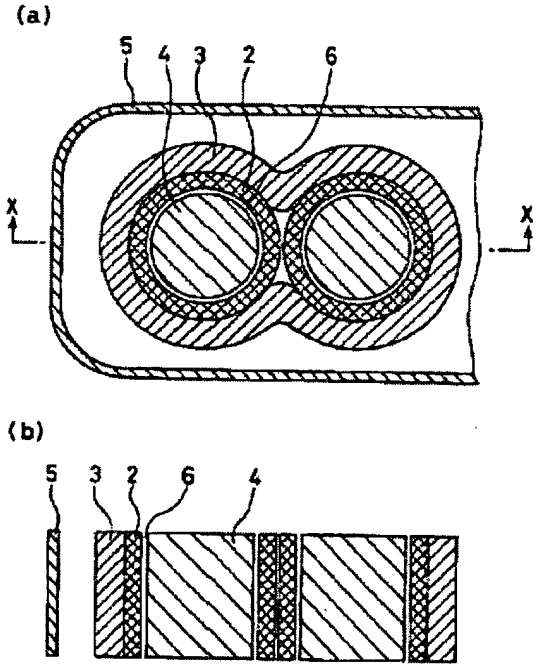
Production of a cylinder block

(57) [Abstract]

[Purpose] The purpose of the present invention is to provide a method of producing a cylinder block by which a reduction in the temperature of the pre-heated preform at the time of

casting the cylinder block can be prevented, wherein impregnation of the preform with a metal matrix can be adequately achieved, exposure of the reinforcing fiber on the inside surface of the bore is prevented and the machinability of the bore is improved so that precision finishing of the bore surface can be easily achieved.

[Means of solution] Upon casting, cylindrical fiber-reinforced preform 2 used for reinforcement of the region surrounding the cylinder bore of a cylinder block is fitted into core 3 used for formation of the water jacket in such a manner that the outer portion of the aforementioned preform comes in contact with the core, space 6 is formed between the aforementioned preform 2 and bore pin 5 arranged for producing the cylinder bore, and space 6 between the aforementioned bore pins 5 and preform 2 is used as a passageway for the melt, and the matrix metal melt impregnates the above-mentioned preform and a cast molding is formed under pressure.



[Claim of the invention]

[Claim 1] A method of producing a cylinder block in which a cylindrical fiber-reinforced preform used for reinforcement of the region surrounding the cylinder bore of the cylinder block is arranged inside the casting die, and a melt of the matrix metal is impregnates the above-mentioned preform and molding is done under pressure, which method of producing a cylinder block is characterized by the fact that the aforementioned preform is fitted into the core used for formation of the water jacket in such a manner that the outer portion of the aforementioned preform comes in contact with the core, a space is formed between the aforementioned preform and bore pins arranged for formation of the cylinder bore, and the space between the aforementioned bore pins and preform serves as a passageway for the melt.

[Detailed description of the invention]

[0001]

[Technical field of the invention] The present invention pertains to a method of producing a metal matrix composite that is a fiber-reinforced component used for cylinder blocks of engines.

[0002]

[Prior art] In the field of materials used for production of automobiles, development of performed metal matrix composites (MMC: metal matrix composite) is being actively pursued in such composites dissimilar materials are used in combination to achieve the target properties, and among them particle-reinforced metal matrix composites and fiber-reinforced metals (FRM : fiber reinforced metal), etc. can be mentioned.

[0003] The above-mentioned metal matrix composites are being developed as lightweight

structural materials, and when a reinforcement material having high strength, high modulus, high hardness, high wear resistance, high heat resistance, etc. is mixed, improved performance that is not possible with a single material can be achieved.

[0004] Thus, the material is used in the field of automobiles where remarkable changes are taking place in terms of weight reduction, and in particular, reduced size and reduced weight are being promoted for engine parts of automobiles based on the high demand for reduced fuel consumption and high output, and as a reinforcement technology for aluminum a development of engine parts that utilize MMC's (metal matrix composites) that form composites with ceramic fibers to increase heat-resistance, wear resistance and strength of components made of aluminum alloys is being promoted.

[0005] Furthermore, in the production of a fiber-reinforced metal matrix composite, reinforcement ceramic fibers such as alumina or silicon carbide whiskers are solidified with a binder to produce a preform, die casting or compression casting is carried out for a light alloy of metals such as aluminum, titanium, and magnesium used as the molten matrix metal at the time of casting and the matrix metal impregnates the aforementioned preform.

[0006] In the production of a cylinder block for engines by the prior art, reinforcement of the liner based on formation of an MMC is achieved by pre-heating cylindrical preform 20 to a temperature in the range of 300°C to 800°C produced by baking ceramic fibers, and fitting to bore pins 4 made of steel used for formation of the cylinder bore in such a manner that the inside of the preform comes in contact with the bore pins so as to form a gap 60 around the above-mentioned preform 20, and sand core 3 for formation of the water jacket is arranged, and mold 5 that forms the outside of the cylinder block is arranged on the outside, and pressure is applied to

molten alumina under a pressure of 49 MPa to 98 MPa (500 kgf/cm^2 to 1000 kgf/cm^2) and casting is done to achieve formation of the MMC. In other words, gap 60 is formed between preform 20 and sand core 3 and serves as a passage for the melt.

[0007] The volume fraction (VF) of the cylindrical preform material made of alumina fibers (density of 3.9 g/cm^3) used for the MMC reinforcement of the alumina cylinder block is in the range of 15% to 30%, and the density of the preform itself is a very low 1.17 and has a porous structure.

[0008] For this reason, when the temperature of the preform is low at the time of impregnating with the aluminum, the flow properties of the impregnating aluminum are reduced, and resistance to impregnation of the aluminum is increased; thus, a compression force is applied to the preform layer at the time of formation of MMC and destruction occurs, in some cases.

[0009]

[Problems to be solved by the invention] However, in the prior art, the preform is fitted to a bore pin made of steel installed inside a die casting mold made of steel after pre-heating the preform; thus, the heat of the pre-heated preform is conducted by the bore pin which has high thermal conductivity, and heat is robbed from the preform; thus, the preform cools rapidly and the pre-heat temperature is reduced before the melt can be poured, and becomes a cause of impregnation defects in the casting.

[0010] The temperature of the above-mentioned preform required for formation of an adequate MMC (metal matrix composite) is at least 300°C but the reduction in time between mold setup and pouring of melt that can be achieved is limited.

[0011] Furthermore, when bore pins and preform are set in close contact without any gap, the

inside the surface of the bore after die casting becomes the MMC area high in wear resistance achieved through impregnation of the matrix metal into the reinforcement fibers, and hard reinforcement fibers are present on the sliding surface of the bore. Therefore, precision machining and polishing of the bore cannot be done easily, and the cutting tools required for machining becomes very expensive, since, for example diamond cutting tools may be required, and furthermore, the area MMC treated is not made of a single material; thus, selection of the cutting speed is difficult, and the life of the tool is short, thus, production costs are high. Furthermore, when the piston comes in direct contact with the above-mentioned MMC area, wear of the piston where it comes in contact is promoted.

[0012] Therefore, coating of the bore with a layer by electrolytic plating such as Ni, Ni-P, or Cr to prevent direct contact the above-mentioned piston surface with the reinforcement fiber is conceivable, but many of the above-mentioned ceramic type reinforcement fibers lack conductivity, thus, plating is difficult in the ceramic fiber areas and adhesion is reduced and cannot be used in practice.

[0013] Meanwhile, production of a cylinder block in which the preform used for production of the bore member of the cylinder block is set up with a shape retention member, and pre-heating is provided, and it is set in the die, then, impregnation with the melt is carried out to form a composite and the shape retention member is removed by machining has been proposed in Japanese Kokai [Unexamined] Patent Application No. Hei 8-197229 [1998].

[0014] According to the above-mentioned method, the shape retention member is made of a baked porous metal having a high thermal capacity, good air permeability, and serves to protect and position the preform, and the preform is held by the above-mentioned shape-retention

member from inside so as to promote protection against reduction of the pre-heating temperature and to secure good air permeability.

[0015] However, in the above-mentioned manufacturing method, a shape-retention member is required, and removal of the shape-retention member by machining is required, as well; thus, the length and complexity of the production process is increased and a higher cost results. In addition, problems such as processing of the bore interior, accelerated wear of the piston, and adhesion of electroplating remain unsolved.

[0016] The aim of present invention is to eliminate the above-mentioned existing problems and to provide a method of producing a cylinder block in which a reduction in the temperature of the pre-heated preform can be prevented at the time of casting the cylinder block, impregnation of the preform by the matrix metal can be adequately achieved, exposure of the reinforcement fiber on the inside surface of the bore is prevented and the machinability of the bore is improved so that precision finishing of inside surface of the bore can be done easily.

[0017]

[Means to solve the problem] In order to achieve the above-mentioned purpose, the present invention is a method of producing a cylinder block characterized by the fact that the aforementioned preform is fitted to a sand core used for formation of the water jacket in such a manner that the periphery of the aforementioned preform comes in contact with the sand core, a gap is formed between the aforementioned preform and bore pins that form the cylinder bore is arranged, and the space between the aforementioned bore pins and preform serves as a passage way for the melt in the production of a cylinder block in which a cylindrical fiber-reinforced preform is used to reinforce the area surrounding the cylinder bore of the cylinder block and said

preform is arranged inside the casting die, and the matrix metal melt impregnates the above-mentioned preform and molding is done under pressure.

[0018] In other words, in the method of producing a cylinder block of the present invention, the inner circumference of the sand core used for the water jacket is used as a guide for setting the preform, and cooling of the preform that takes place between set up of the mold and pouring of the melt is delayed by the thermal insulation effect of the sand in the sand core and the space formed between the bore pin and preform; thus, an MMC (metal matrix composite) layer can be produced without flaws.

[0019] In other words, the difference in thermal conductivity between the bore pin made of steel and the core made of sand or salt is taken into consideration and the preform is separated from the bore pin having high thermal conductivity and set close to the core which has low thermal conductivity and a high thermal insulation effect and the conduction of heat is restricted and the preform can be maintained in a high temperature state.

[0020] Furthermore, when a gap is formed between the bore pin and preform, the surface of the bore to be machined can be made of the aluminum used as the matrix metal, and machining of the inside surface of the bore and post treatments such as plating can be done easily.

[0021] Furthermore, according to the above-mentioned method, a layer of matrix metal is formed on the inside surface of the bore, and therefore the piston does not come in direct contact with the hard reinforcement fibers included in the preform used for reinforcement; thus, wear of the sliding component is reduced. Furthermore, machinability of the above-mentioned matrix metal layer is good, and precision processing of the sliding surface can be easily achieved.

[0022]

[Embodiment of the invention] In the following, the present invention is explained further with reference to the attached drawings. In the method of producing a cylinder block of the present invention, cylindrical fiber reinforced preform 2 is arranged inside mold 5 as shown in Fig. 1, the preform 2 is impregnated with the matrix metal melt and pressure molding is carried out.

[0023] Furthermore, a cylindrical preform is fitted to core 3 made of sand or salt used for formation of the water jacket in such a manner that the outer circumference of the cylindrical preform comes in contact with the core, gap 6 is formed on the inside of the above-mentioned preform, the bore pin is arranged for formation of bore and gap 6 is formed between the above-mentioned bore pin 4 and the preform and serves as a passage for the melt.

[0024] Furthermore, preform 2 has a cylindrical shape and an inner radius such that a layer of the matrix metal is formed on the inside surface. Furthermore, the diameter of the bore pin is reduced so that the specified gap 6 is formed at the outer circumference of the bore pin 4. In general, the above-mentioned gap 6 is in the range of 1.5 mm to 3.0 mm.

[0025] In this case, for the reinforcement fiber, alumina fiber, alumina-silica fiber, carbon fiber, silicon carbide fiber, boron fiber, and combinations thereof can be used, and for the binder, synthetic resin binders such as phenolic resins, furan resins, acrylic resins and epoxy resins, and inorganic ceramic binders such as alumina and silica can be used, and the above-mentioned materials are used in combination to produce the preform.

[0026] And as shown in the diagram of Fig. 1, mold 5, core 3 for formation of the water jacket are arranged, and other required cores (not shown in the figure) and the cylinder bore pins 4 are arranged, and casting is carried out. The matrix metal melt consisting of a light alloy of aluminum or magnesium is poured into mold 5, pressure is applied to the piston (not shown in

the figure) and pressure is applied to the mold, and the melt impregnates preform 2 and molding of the cylinder block is achieved.

[0027] The preform is fastened to core 3 at the time of pouring the melt; thus, dislocation can be prevented. Furthermore, the melt flows from gap 6 and impregnates the preform upon application of pressure, and a uniform distribution of pressure can be achieved inside the mold; thus, deformation or destruction of the preform can be avoided, and the MMC (metal matrix composite) member can be formed with high precision. Furthermore, the preform is not present in the region of the above-mentioned gap 6; thus, the matrix metal alone exists in that space and a matrix metal layer having the same thickness as gap 6 is formed.

[0028] In this case, a layer without reinforcement by the reinforcement fiber is formed, and the reduction in deterioration in overall strength can be controlled when the thickness of the matrix layer is reduced to approximately 0.1 to 1.0 mm at the time of machining.

[0029] Subsequently, after cooling and solidification of the melt, the molded cylinder block is removed and precision machining is done to produce cylinder bores of the correct size and shape. In this case, the hard reinforcement fibers are covered by the layer of matrix metal, and machining can be done easily.

[0030] In some cases, in order to further improve the sliding of the piston, plating is carried out for the surface of the cylinder bore. In this case also, the non-conductive reinforcement fiber is not exposed; thus, a uniform plating can be applied to the overall surface and plating with good adhesion can be achieved. When the above-mentioned plating is done, the plating layer is formed on the surface of the cylinder bore that comes in contact with the piston, and the matrix metal layer is formed outside the above-mentioned layer and reinforced by the reinforcement

fiber, and a cylinder block having a region with high wear resistance can be produced.

[0031] According to the above-mentioned method of producing a cylinder block, when cylindrical preform 2 is set inside sand core 3 for the water jacket and placed in die casting mold 5, loss of heat to the bore pin is eliminated, and a reduction in the temperature of the preform can be prevented based on the thermal insulating effect of the sand that comprises sand core 3, and rapid cooling of the melt at the time of die casting can be prevented. As a result, impregnation of the molten aluminum alloy into the preform made of the reinforcement fiber can be smoothly achieved, and formation of a high-quality MMC can be achieved.

[0032] Furthermore, when a gap 6 is formed between bore pin 4 and preform 2, and a melt of aluminum alloy is poured in; a layer comprising the matrix metal alone can be formed at the inner surface of the bore of the cylinder block and exposure of the MMC on the inside surface of the bore can be prevented.

[0033] The above-mentioned matrix metal layer exhibits excellent machinability, and the machinability of the inside bore can be prevented; thus, precision machining of the cylinder bore can be achieved; furthermore, factors such as material and type of cutting tools, cutting speed, etc. can be simplified significantly compared to those used for machining the metal matrix composite, as a result, machining costs can be reduced.

[0034] Furthermore, in the cylinder block produced as described above, a layer made of the matrix metal alone with an absence of a ceramic reinforcement fiber can be formed on the inside surface of the cylinder bore, and the sliding piston does not come into direct contact with the hard reinforcement fiber of the MMC; thus, the degree of wear of the piston can be reduced.

[0035] Furthermore, non-conducting areas where the reinforcement fiber is exposed on the

surface of inside the cylinder bore are eliminated; thus, electrical conductivity of the surface can be secured, and uniform plating with good overall adhesion to the surface can be achieved; thus, electrolytic plating of materials such as Ni, Ni-P, and Ni-Cr or chemical plating such as Ni and Cu can be easily done.

[0036] Therefore, electrolytic plating is carried out for the surface of the above-mentioned matrix metal layer, and a plating layer with a thickness in the range of approximately 0.03 mm to 0.2 mm is formed, the matrix metal layer is protected by an electrolytic plating layer of a material such as Ni, Ni-P, and Ni-Cr or by a chemical plating layer of a material such as Ni and Cu, thus, the overall wear resistance of the cylinder block can be increased.

[0037]

[Effect of the invention] As described above, according to the method of producing a cylinder block of the present invention, loss of heat to the cylinder bore pin can be eliminated when the cylindrical preform is arranged on the sand core for the water jacket and set inside the die casting mold, and a reduction in the temperature achieved in the pre-heat can be prevented based on the thermal insulation effect of the sand; thus, a significant reduction in the temperature of the preform can be prevented, and rapid cooling of the melt at the time of die casting can be prevented. As a result, impregnation of the molten aluminum alloy into the reinforcement fibers of the preform can be smoothly achieved, and formation of a high-quality MMC (metal matrix composite) can be achieved.

[0038] Furthermore, when a gap is formed between the bore pin and preform, flow of the aluminum melt around the preform is made possible at the time of die casting, and a layer comprising the matrix metal alone can be formed on the inside surface of the bore, and exposure

of the MMC on the inside surface of the bore can be prevented. Therefore, precision machining of the cylinder bore can be done easily, and furthermore, factors such as the material and type of cutting tools, cutting speed, etc. can be simplified significantly compared to those required for machining the metal matrix composite; as a result, machining cost can be reduced.

[0039] Furthermore, a matrix metal layer without the reinforcement fiber being exposed on the surface can be formed inside the bore; thus, the wear of piston can be reduced, and improved adhesion of the electrolytic plating can be achieved; thus, electrolytic plating can be used, as well.

[Brief description of figures]

[Fig. 1] A diagram that shows the structure illustrating the method of producing the cylinder block of the present invention; (a) is the cross-section view from the top and (b) is the cross-section view at line X-X.

[Fig. 2] A diagram that shows the structure illustrating the method of producing a cylinder block of the prior art; (a) is the plane cross-section view and (b) is the cross-section view at line Y-Y.

[Explanation of codes]

2, 20: Preform

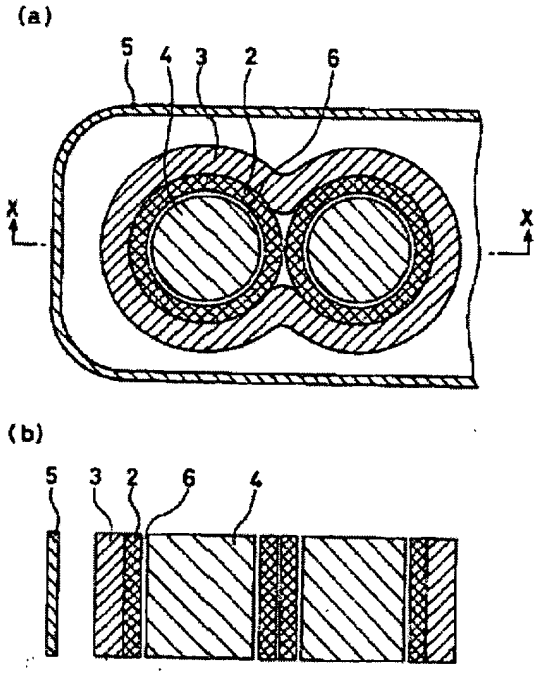
3: Sand core (for formation of water jacket)

4: Cylinder bore (for formation of cylinder bore)

5: Mold (for formation of external cylinder block)

6, 60: Space (melt passage)

[Fig. 1]



[Fig. 2]